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Quebec Region

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Science Advisory Report 2016/023

ASSESSMENT OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13 TO 17, 12A, 12B, 12C AND 16A) SNOW CRAB STOCKS IN 2015

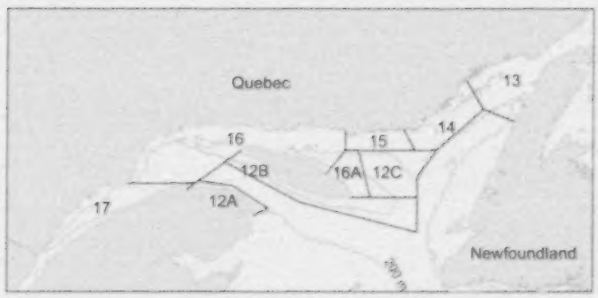

Figure 1. Snow Crab management areas in the Estuary and the northern Gulf of St. Lawrence.

Context:

The Snow Crab fishery in the Estuary and the northern Gulf of St. Lawrence began in the late 1960s. The fishery grew at a very fast pace from 1979 to 1985. TAC-based management was gradually introduced between 1985 and 1995. There are nine management areas (13 to 17, 16A, 12A, 12B and 12C) (Figure 1).

Landings have varied depending on the adjusted TACs based on recruitment waves and troughs that affect the quantity of crabs available to the fishery (Figure 2), with maximum levels recorded in 1995 (7,879 t) and 2002 (10,372 t). Landings dropped considerably in 2003 owing to the lower TACs established in response to signs of overfishing, mainly in Area 16. Landings totalled 8,554 t in 2015.

The fishery targets only males with a carapace width ≥ 95 mm. White Crab (crab that has recently moulted) and adolescent males may be returned to the water during the fishing season to enhance their meat yield and give them a chance to reproduce. Furthermore, since 1985, when the proportion of White Crab in catches at sea exceeds 20%, the fishery in the area concerned is automatically closed. This measure aims to minimize the mortality of these very fragile crabs that will be available to the fishery the following year.

The DFO Fisheries and Aquaculture Management Branch, Quebec Region, requested a resource status assessment as well as a science advisory report, in order to set the 2016 quotas. A scientific peer review was conducted on February 16 and 17, 2016. Participants included representatives from DFO Science and Fisheries and Aquaculture Management, the fishing industry and First Nations.

SUMMARY

- Stocks in the Middle and Lower North Shore of the Gulf of St. Lawrence (Areas 13, 14, 15, 16, 16A and 12C) had high commercial biomass. Only areas 16A and 12C showed signs of a decline in 2015. Fishery recruitment throughout these areas is still relatively high, but should decrease in the short (2016) or medium term (2017–2018). Conversely, the commercial biomass remains low in Area 17 despite a rise in 2015 caused by a recruitment that has started to recover. The commercial

biomass in Areas 12A and 12B shows a decrease and recruitment during the next few years could depend on productivity in adjacent areas.

- The purpose of conservation is to maintain an adequate male reproductive biomass in order to ensure the recovery or maintenance of the population in a given area. Recommendations assume that the natural mortality rate will be the same in 2016 as in previous years.

Outlook

Area 17

- The rise in the combined index suggests a possible increase in catches in 2016 compared to 2015:
  1) An increase of 30% or more in catches would lead to a high harvesting intensity, which would slow the rate of expected increase in biomass available to the fishery and increase the risk of catching white crab;
  2) An increase of approximately 20% should lead to a moderate harvesting intensity and help increase the biomass available to the fishery;
  3) Any increase less than 15% could support an even more rapid increase in the biomass available to the fishery and reduce the risk of catching white crab.

Area 16

- The slight rise in the combined index suggests that it is possible to maintain or slightly increase catches in 2016 compared to 2015:
  1) An increase in catches greater than 10% would lead to a high harvesting intensity and could reduce the biomass available to the fishery in 2017;
  2) It is unlikely that a status quo or a maximum increase of 10% would lead to an excessively high harvesting intensity and would moderate the effects of lower expected recruitment in the medium term;
  3) Any decrease in catches could help maintain a substantial biomass available to the fishery over a longer period of time.

Area 15

- The combined index suggests that it is possible to slightly increase 2016 catches compared to 2015:
  1) An increase in catches greater than 10% could lead to a high harvesting intensity and would increase the expected biomass decline due to lower expected recruitment;
  2) It is unlikely that a 10% maximum increase would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
  3) A status quo or decrease in catches could help maintain a substantial biomass available to the fishery over a longer period of time.

Area 14

- The combined indicator declined slightly but remains very high, suggesting that catches in 2016 could be maintained at the 2015 level:
  1) An increase in catches could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;

2) It is unlikely that a status quo would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
3) A decrease in catches could help maintain a substantial biomass available to the fishery over a longer period of time.

Area 13

- The rise in the combined index suggests that 2016 catches may be increased compared to 2015:
  1) An increase in catches greater than 20% could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;
  2) It is unlikely that a 20% maximum increase would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
  3) A lower increase or a status quo could lead to the maintenance of a substantial biomass available to the fishery over a longer period of time.

Area 12A

- The drop in the combined index suggests that 2016 catches should decrease compared to 2015:
  1) A decrease of 20% or less in catches could lead to high harvesting intensity and a decrease in biomass available to the fishery in 2017;
  2) A decrease of approximately 30% should lead to a moderate harvesting intensity and help stabilize the biomass available to the fishery;
  3) An even greater decrease could help increase the biomass available to the fishery in the medium term.

Area 12B

- The uncertainty linked to the crab's range during the post-season survey provides a rationale for increasing the weighting of the commercial biomass indicator during the fishery (CPUE). However, this indicator suggests that 2016 catches should decrease compared to 2015:
  1) A decrease in catches of 10% or less could lead to high harvesting intensity.
  2) A decrease of approximately 15% could lead to moderate harvesting intensity.
  3) A greater decrease could help stabilize the biomass available to the fishery.

Area 12C

- The drop in the combined index suggests that 2016 catches should decrease compared to 2015:
  1) A status quo in catches could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;
  2) It is unlikely that a 10 to 15% decrease would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
  3) Any decrease greater than 15% could lead to the maintenance of a substantial biomass available to the fishery over a longer period of time.

Area 16A

- The uncertainty linked to the crab's range during the post-season survey provides a rationale for increasing the weighting of the commercial biomass indicator during the fishery (CPUE). However, this indicator suggests that 2016 catches should decrease compared to 2015:

1) A less than 15% decrease in catches could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;
2) It is unlikely that a 15 to 20% decrease would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
3) Any greater decrease could help maintain a substantial biomass available to the fishery over a longer period of time.

INTRODUCTION

Species biology

In Canada, Snow Crab can be found from the southern tip of Nova Scotia to halfway up the Labrador coast, as well as in the Estuary and Gulf of St. Lawrence. In the Gulf of St. Lawrence, commercial-size males live at depths ranging from 60 m to 220 m, except during their winter moulting and reproductive periods, during which they migrate to shallower waters. Snow Crab stop growing after the terminal moult. Males are considered adolescents (small claws) prior to the terminal moult and adults (large claws) afterwards. Male carapace width (CW) ranges from 40 mm to 165 mm after the terminal moult. If they do not undergo their terminal moult earlier, males reach legal size (95 mm CW) at about nine years of age. The proportion of males that reach the legal size is correlated with the temperature of the environment throughout their development. Snow Crab recruitment is periodic or episodic and varies considerably over an 8- to 12-year cycle. The entry of recruits into the fishery can be determined by regular monitoring of landings (carapace size and condition) and the catch rate (catch per unit effort, CPUE), and is confirmed by scientific trap and trawl surveys. Global warming and specifically the gradual increase in recent years in the deep layer's average temperature could affect Snow Crab distribution and productivity by warming and thinning the cold intermediate water layer, its habitat.

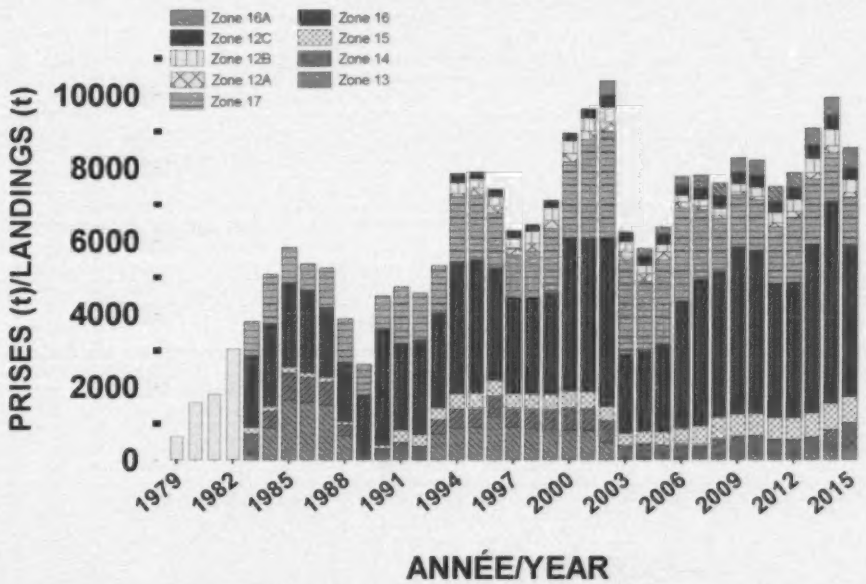

Figure 2. Snow Crab landings in the Estuary and northern Gulf of St. Lawrence. From 1979 to 1982, landings were not attributed to their area of origin.

ASSESSMENT OF THE RESOURCE

Analyses of all areas are based on fishing data from logbooks, processing plant purchase slips and dockside weighing summaries, along with catch sampling data obtained from the Observers Program and DFO samplers. In 2015, the industry conducted a trap-based research survey in all fishing areas (except in Area 13 where two independent surveys were conducted) and the findings were incorporated into the stock status analyses. These surveys help determine the average NUE (numbers per unit effort) of legal-size crabs by area and the NUE of adolescent crabs with carapaces over 78 mm wide that will reach or exceed legal size during the next moult. In Area 17, the catch of adolescent crabs from the experimental traps, which have a smaller mesh (15 mm when stretched), during the post-season survey was also examined to obtain an early indication of the strength of the cohorts that would reach the legal size. The results of the trawl research surveys conducted in 2014 and 2015 in Areas 13 and 17 were used to calculate a juvenile or adult crab abundance index.

The fishery's raw catches per unit effort (CPUE) were standardized using an additive model to account for seasonal changes, gear type, soak time and fishing site. The proportion of recruits (or new crabs), which can be identified by their new carapace (carapace conditions 1 and 2), was determined by dockside samplers.

A combined index was developed to obtain a better estimate of the short-term commercial biomass trend and help increase the consistency of the inter-annual recommendations for a given stock. This index is based on the two biomass indices, that is, the post-season NUE for adult males ≥ 95 mm (the average NUE from the north and south surveys in Area 13) and the standardized commercial CPUE. The combined index is calculated by standardizing each of the indices according to their respective average and standard deviation over the 2000-2012 reference period and averaging them for the current year.

Data on the size structure of crabs sampled at sea, dockside and during trap surveys were also used.

To date, data on female insemination levels have been collected sporadically in certain areas. Annual systematic sampling of each area is recommended so this parameter can be used for stock status assessments because it is a measure of primiparous female mating success and the relative abundance of large adult males.

Area 17

Description of the Fishery

In Area 17, there are 21 fishers who hold traditional licences in group A (88% of the TAC) and 20 fishers who hold not traditional licences in group B (12% of the TAC). The TAC decreased by 7% between 2014 and 2015 to 1,342 t (Figure 3). The fishing season opened on April 2 and closed on June 20. Catches totalled 1,334 t.

Resource status in 2015

Commercial fishery. The standardized CPUE increased from 2014 to 2015 but remains below the historical average (Figure 4). Landings have been dominated by intermediate-shell crabs (carapace condition 3) since 2010 because of low recruitment. There was a sharp decline in the average size of legal-size crabs caught at sea from 2013 (113.0 mm) to 2015 (108.7 mm).

Fishery-independent surveys. The trap-based research survey, a data series that began in 1996 on the north shore and in 1999 on the south shore, indicates that the NUE of adults ≥ 95 mm increased in 2015 (Figure 5) despite a slight decrease in the number of recruits (Figure 6). It nonetheless remains well below average. The NUE in adolescents increased and is above average (Figure 6). An examination of the catch from the traps with a smaller mesh (experimental traps) in 2014 and 2015 and

the results of the trawl survey conducted in 2015 also showed a large number of adolescent crabs between 62 and 95 mm, which should lead to a greater recruitment to the fishery in the next three or four years. Thus, given the low residual biomass, there is a high risk of observing a large number of White Crab (carapace condition 1) in the catches. The average size of legal-size adult crabs remained low (104.6 mm) during the 2015 post-season survey, suggesting that it will be low during the 2016 commercial catch.

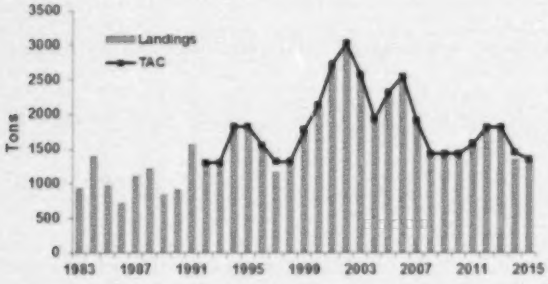

Figure 3. Landings and TAC in Area 17 from 1983 to 2015.

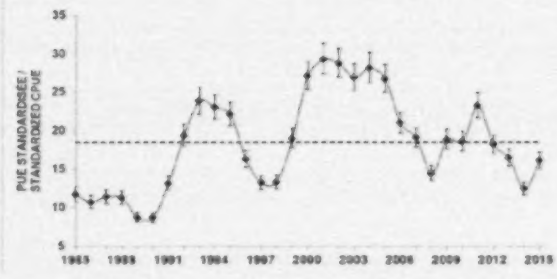

Figure 4. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2015 in Area 17. The dotted line shows the data series average.

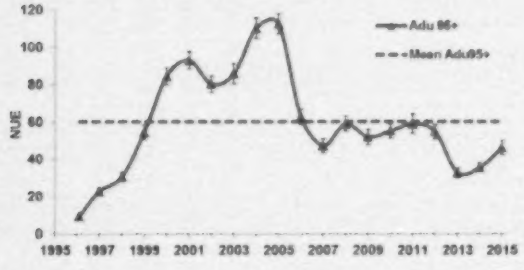

Figure 5. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm, from the post-season survey in Area 17 from 1996 to 2015.

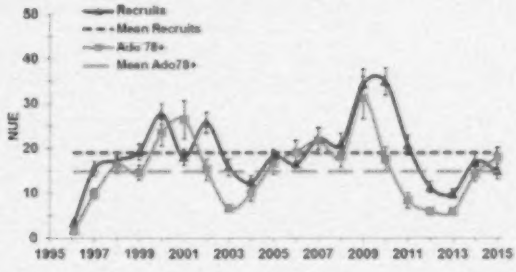

Figure 6. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 17 from 1996 to 2015.

The combined index of commercial CPUE and of NUE from the post-season survey increased in 2015 compared to 2014 but remains below average. This index suggests that there will be more biomass available to the fishery in 2016 than there was in 2015.

In 2015, the average amount of sperm stored in the females' spermathecae was low compared to the average, indicating a sex ratio imbalance favouring females.

Perspectives and conclusions

The rise in the combined index suggests a possible increase in catches in 2016 compared to 2015:

1) An increase of 30% or more in catches would lead to a high harvesting intensity, which would slow the rate of expected increase in biomass available to the fishery and increase the risk of catching white crab;
2) An increase of approximately 20% should lead to a moderate harvesting intensity and help increase the biomass available to the fishery;

3) Any increase less than 15% could support an even more rapid increase in the biomass available to the fishery and reduce the risk of catching white crab.

Area 16

Description of the Fishery

In Area 16, there are 38 fishers who hold traditional Snow Crab licences (group A with 92.7% of the TAC) and 16 who hold not traditional licences (groups B and C with 7.3% of the TAC). In 2015, the TAC decreased by 25%, to 4,145 t, after reaching a peak of 5,527 t in 2014 (Figure 7). The fishery opened on April 13 and closed on July 19. The TAC was reached.

Resource status in 2015

Commercial Fishery. The standardized CPUE has remained stable since 2013 and is sharply above the historical average (Figure 8). Landings from 2006 to 2014 consisted primarily of recruits (carapace conditions 1 and 2), likely due to a high fishing pressure at the start of this period followed by a strong recruitment to the fishery. In 2015, landings consisted of a slight majority of intermediate-shell crab (carapace condition 3).

Fishery-independent surveys. The trap-based research survey, conducted each autumn since 1994, indicates that the NUE of adults ≥ 95 mm increased in 2015 compared to 2014 (Figure 9) due to a high abundance of recruits that offset the decrease in crab left by the fishery (Figure 10). The commercial biomass index is well above average. Like the post-season survey, the trawl survey conducted in the western part of the area (Baie Sainte-Marguerite) indicates an increase in the abundance of adolescents of ≥ 78 mm in 2015. Conversely, the trawl survey results suggest that recruitment will decline in the medium term.

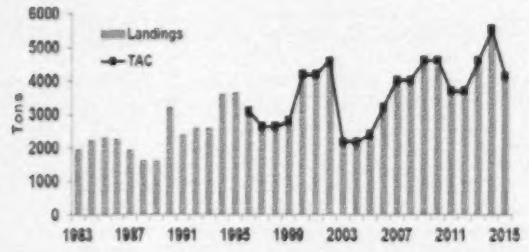

Figure 7. Landings and TAC in Area 16 from 1983 to 2015.

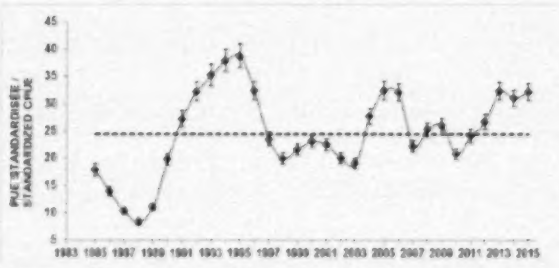

Figure 8. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2015 in Area 16. The dotted line shows the data series average.

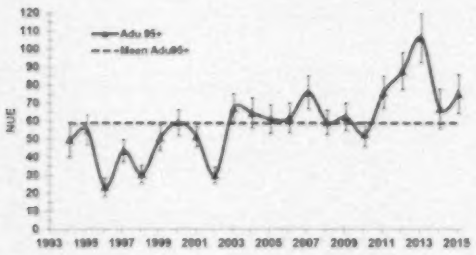

Figure 9. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-

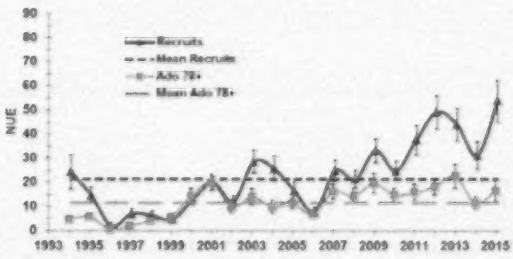

Figure 10. Catch rates (NUE), with confidence interval and average, of recruits and adolescents ≥ 78 mm from

season survey in Area 16 from 1994 to 2015. *the post-season survey in Area 16 from 1994 to 2015.*

The combined index of commercial CPUE and of NUE from the post-season survey slightly increased and remains at a high level, suggesting that the biomass available to the fishery in 2016 will be slightly higher than in 2015.

The spermathecae of primiparous females from Baie Sainte-Marguerite contained more sperm in 2015 than in the previous seven years, indicating a sex ratio favouring large males.

Perspectives and conclusions

The slight rise in the combined index suggests that it is possible to maintain or slightly increase catches in 2016 compared to 2015:

1) An increase in catches greater than 10% would lead to a high harvesting intensity and could reduce the biomass available to the fishery in 2017;
2) It is unlikely that a status quo or a maximum 10% increase would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment in the medium term;
3) Any decrease in catches could help maintain a substantial biomass available to the fishery over a longer period of time.

Area 15

Description of the Fishery

In Area 15, there are eight fishers who hold traditional licences (group A with 90.7% of the TAC) and 38 fishers who hold not traditional licences (group B with 9.3% of the TAC). After peaking in 2014, the TAC remained unchanged, at 718 t, in 2015 (Figure 11) and was reached. In 2015, the fishery opened on April 19 and closed on July 25.

Resource status in 2015

Commercial Fishery. The standardized CPUE increased slightly in 2015 compared to 2014 and remains well above the historical average (Figure 12). Landings since 2014 were primarily intermediate-shell crabs (carapace condition 3), while recruits (carapace conditions 1 and 2) were still plentiful.

Fishery-independent survey. The trap-based research survey, conducted since 1998, shows a slight increase in the NUE of adults ≥ 95 mm, which is a relatively high value (Figure 13) because of heavy recruitment (Figure 14). The NUE of adolescent crabs ≥ 78 mm was lower in 2014 and 2015, despite a slight rise in 2015, than from 2011 to 2013 (Figure 14), suggesting a decline in recruitment.

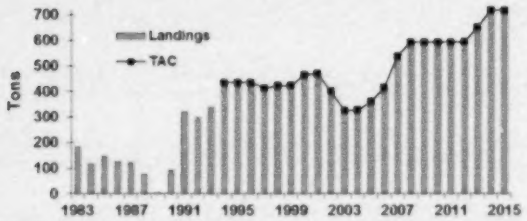

Figure 11. Landings and TAC in Area 15 from 1983 to 2015.

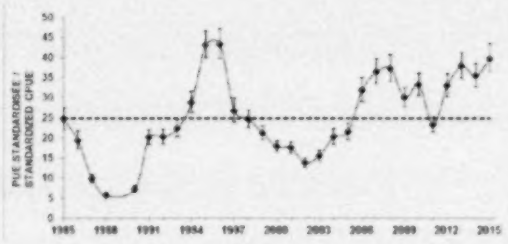

Figure 12. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2015 in Area 15. The dotted line shows the data series average.

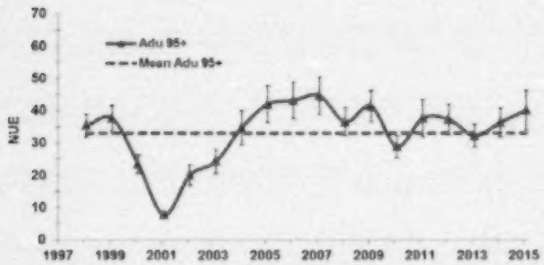

Figure 13. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-season survey in Area 15 from 1998 to 2015.

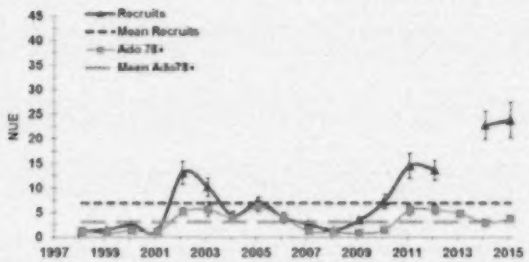

Figure 14. Catch rates (NUE), with confidence interval and average, of recruits and adolescent crabs ≥ 78 mm from the post-season survey in Area 15 from 1998 to 2015. The NUE of recruits was not determined in 2013.

The combined index of commercial CPUE and of NUE from the post-season survey increased slightly from 2014 to 2015 and is at a relatively high value. This index suggests that there will be equal or slightly more biomass available to the fishery in 2016 than there was in 2015.

Perspectives and conclusions

The combined index suggests that it is possible to slightly increase 2016 catches compared to 2015:

1) An increase in catches greater than 10% could lead to a high harvesting intensity and would increase the expected biomass decline due to lower expected recruitment;
2) It is unlikely that a maximum increase of 10% would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
3) A status quo or decrease in catches could help maintain a substantial biomass available to the fishery over a longer period of time.

Area 14

Description of the Fishery

In Area 14, there are 21 fishers who hold traditional licences. The TAC increased by 35% in 2014 and by 20% in 2015, (to 726 t), and was reached (Figure 15). In 2015, the fishing season opened on May 11 and closed on August 16.

Resource status in 2015

Commercial fishery. After increasing strongly from 2013 to 2014, the standardized CPUE increased slightly in 2015 and has a value well above average (Figure 16). Recruits (carapace conditions 1 and 2), whose numbers were increasing in landings from 2008 to 2013, decreased in 2014 and 2015 and thus consisted primarily of intermediate-shell crabs (carapace condition 3) in 2015.

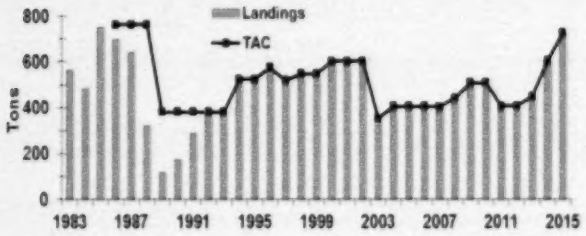

Figure 15. Landings and TAC in Area 14 from 1983 to 2015.

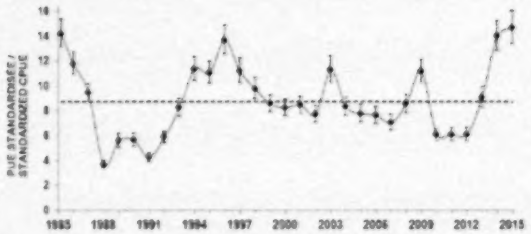

Figure 16. Standardized CPUE ± confidence interval in the commercial fishery from 1985 to 2015 in Area 14. The dotted line shows the data series average.

Fishery-independent survey. The trap-based research survey, conducted since 1996, indicates that the NUE of adults ≥ 95 mm (Figure 17) and of recruits (Figure 18) decreased from 2014 to 2015, but remain at values well above average. The NUE of adolescents ≥ 78 mm has been decreasing since 2013 and is low (Figure 18), suggesting a decrease in recruitment in the short to medium term.

The combined index of commercial CPUE and NUE from the post-season survey decreased slightly but remains at a very high level. This index suggests that the biomass available to the fishery in 2016 will be high, but in slight decline, compared to 2015.

Perspectives and conclusions

The combined indicator declined slightly but remains very high, suggesting that catches in 2016 could be maintained at the 2015 level:

1) An increase in catches could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;
2) It is unlikely that a status quo would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
3) A decrease in catches could help maintain a substantial biomass available to the fishery over a longer period of time.

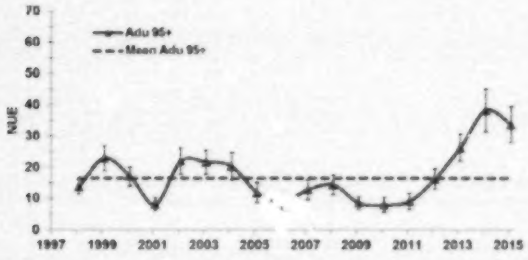

Figure 17. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the fishery, from the post-season survey in Area 14 from 1998 to 2015.

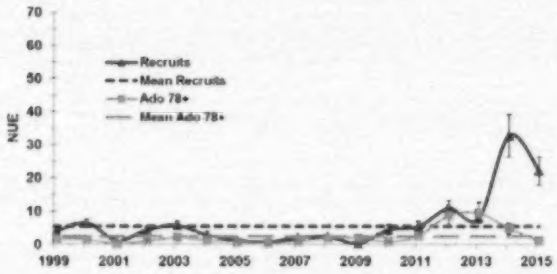

Figure 18. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 14 from 1998 to 2015.

Area 13

Description of the Fishery

Area 13 has 43 traditional fishers from Quebec with 87.76% of the TAC and six traditional fishers from Newfoundland with 12.26% of the TAC. The area was placed under a moratorium from 2003 to 2007 as a result of a marked decline in the biomass of legal-size crab. However, an index fishery with an annual TAC of 50 t was approved in 2003, 2004 and 2006. The area was opened to the commercial fishery in 2008. The TAC was 235 t in 2014, then it increased by 20% in 2015 to 282 t (Figure 19). The fishery opened on May 11 and closed on August 10. The TAC was reached.

Resource status in 2015

Commercial fishery. The standardized CPUE increased in 2015 compared to 2014 and is well above the historical average (Figure 20). Landings consisted primarily of recruits (carapace conditions 1 and 2), whose proportion in landings has been rising since 2010. The fishing effort, which was significantly higher from 2009 to 2014 in the area's southern part than in its northern part, was slightly higher in the northern part than in the southern part in 2015. The average size of legal-size crabs caught at sea decreased to the series average (104 mm) and remains low compared to that of the other northern areas of the Gulf of St. Lawrence.

Fishery-independent surveys. The trap-based research surveys conducted since 1999 indicate that the NUE of adults ≥ 95 mm slightly decreased in the northern part in 2015 compared to 2014 (Figure 21), although it continues to be very high, and increased in the southern part to a value slightly above average (Figure 22). In 2015, the NUE of recruits in the northern part reached the highest value of the series (Figure 23) but remained low in the southern part despite a slight increase compared to 2014 (Figure 24). The average of the two surveys suggests that the commercial biomass available to the fishery will be stable in 2016 compared to 2015. The post-season survey conducted in the southern part indicates a low abundance of adolescents ≥ 78 mm since 2012 (Figure 24). In the northern part, the last trawl survey conducted in 2014 indicates a low abundance of adolescents ≥ 78 mm, whereas the post-season survey (Figure 23) indicates that from 2012 to 2014, adolescents ≥ 78 mm decreased to stable values slightly below average since 2014. These results suggest that recruitment will be lower in the short to medium term. The trawl survey also shows a high abundance of immature crab < 40 mm, suggesting the beginning of a new wave of recruitment to the fishery in at least four years.

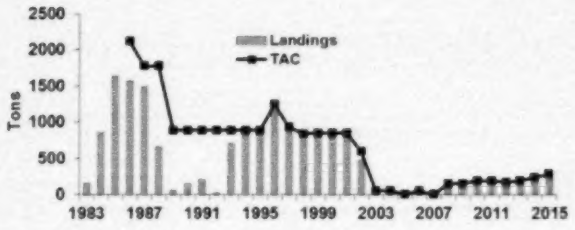

Figure 19. Landings and TAC in Area 13 from 1983 to 2015.

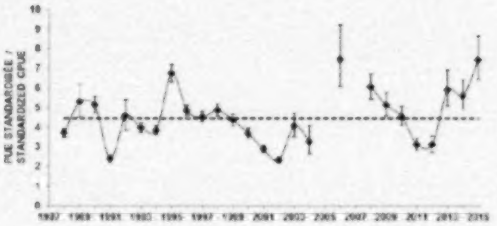

Figure 20. Standardized CPUE ± confidence interval in the commercial fishery from 1988 to 2015 in Area 13. The dotted line shows the 1988–2014 data average.

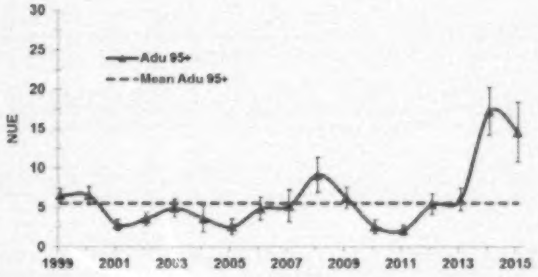

Figure 21. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-season survey in Area 13 North from 1999 to 2015.

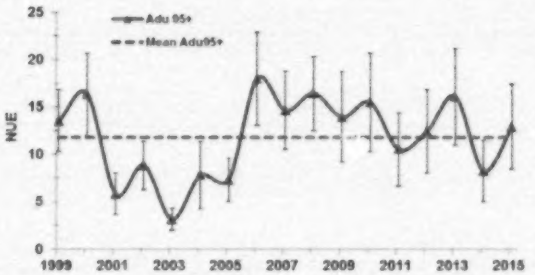

Figure 22. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-season survey in Area 13 South from 1999 to 2015.

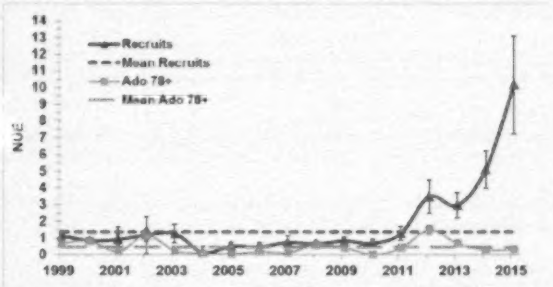

Figure 23. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 13 North from 1999 to 2015.

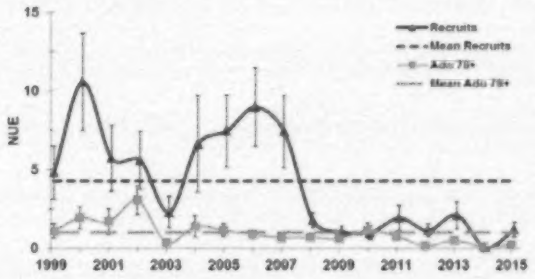

Figure 24. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 13 South from 1999 to 2015.

The combined index of commercial CPUE and of average NUE from the post-season surveys increased for a fourth consecutive year. This index suggests that there will be more biomass available to the fishery in 2016 than there was in 2015.

Perspectives and conclusions

The rise in the combined index suggests that 2016 catches may be increased compared to 2015:

1) An increase in catches greater than 20% could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;

2) It is unlikely that a 20% maximum increase would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;

3) A lower increase or a status quo could lead to the maintenance of a substantial biomass available to the fishery over a longer period of time.

Area 12A

Description of the Fishery

In Area 12A, there are ten traditional licences. The TAC was 191 t in 2014, and decreased by 21% in 2015 to 151 t (Figure 25). In 2015, the fishing season opened on April 1 and closed on June 10. Catches totalled 132 t.

Resource status in 2015

Commercial fishery. The standardized CPUE went from the highest value of the series in 2013 to a below average value in 2015 (Figure 26). There were very few recruits (carapace conditions 1 and 2) in the landings that were heavily dominated by intermediate-shell crabs (carapace condition 3).

Fishery-independent survey. The trap-based research survey, which started in 2000, was not conducted in 2013. The NUE of adults ≥ 95 mm decreased in 2015 compared to 2014, to the lowest value of the series (Figure 27). The NUE of recruits remained stable in 2015 compared to 2014, at the lowest value of the series (Figure 28). The NUE of adolescents ≥ 78 mm decreased in 2015 to a value close to the average (Figure 28).

The combined index of commercial CPUE and of NUE from the post-season survey decreased compared to 2014 and is below the average. The biomass available to the fishery will thus be lower in 2016 than it was in 2015.

It is important to note that the abundance of crabs in Area 12A is partially determined by overflow from adjacent areas 17 to the west and area12 to the east.

Perspectives and conclusions

The drop in the combined index suggests that 2016 catches should decrease compared to 2015:

1) A decrease of 20% or less in catches could lead to high harvesting intensity and a decrease in biomass available to the fishery in 2017;

2) A decrease of approximately 30% should lead to a moderate harvesting intensity and help stabilize the biomass available to the fishery;

3) An even greater decrease could help increase the biomass available to the fishery in the medium term.

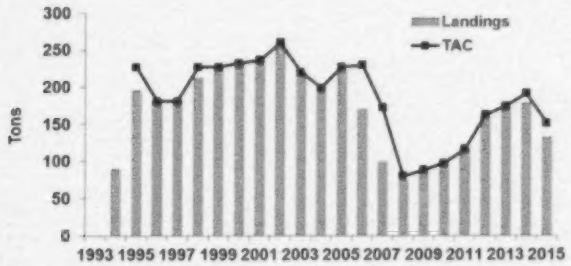

Figure 25. Landings and TAC in Area 12A from 1994 to 2015.

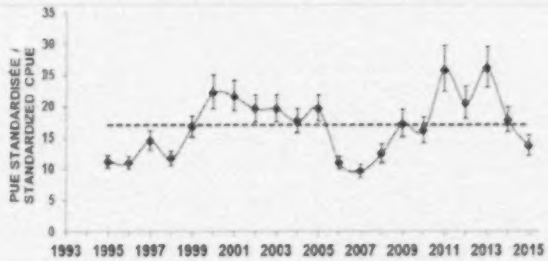

Figure 26. Standardized CPUE ± confidence interval in the commercial fishery from 1995 to 2015 in Area 12A. The dotted line shows the data series average.

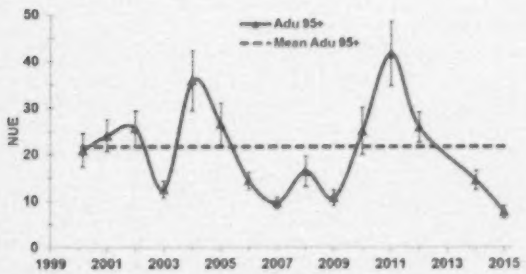

Figure 27. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-season survey in Area 12A from 2000 to 2015.

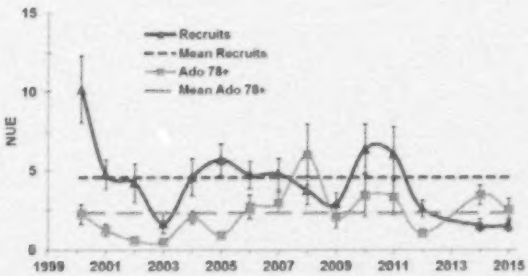

Figure 28. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 12A from 2000 to 2015.

Area 12B

Description of the Fishery

In Area 12B, there are eight traditional licences. The TAC gradually increased from 246 t in 2010 to 468 t in 2014 and then decreased by 22% in 2015, to 366 t (Figure 29). The fishing season opened on March 29 and closed on June 22. Catches totalled 350 t.

Resource status in 2015

Commercial fishery. The standardized CPUE reached the highest value of the series in 2013 and then decreased sharply in 2014 and slightly in 2015, to a value below the historical average of the series (Figure 30). Landings consisted primarily of intermediate-shell crabs (carapace condition 3) each year since 2005, and, in 2015, the proportion of recruits (carapace conditions 1 and 2) was the lowest since 2007.

Fishery-independent survey. The trap-based research survey conducted since 2001 (except in 2005) shows that the NUE of adults ≥ 95 mm (Figure 31), recruits (Figure 32) and adolescents ≥ 78 mm (Figure 32) decreased sharply since 2013 and reached very low values in 2015. These results may suggest a low biomass available to the fishery in the short and medium term. However, the temperature increase in the bottom layer of the Laurentian Channel and the thinning of the cold intermediate layer may have caused the crab to concentrate in shallower waters since 2014, including waters shallower than those covered by the post-season survey. It is possible that a greater part of the population than usual was not sampled during the survey.

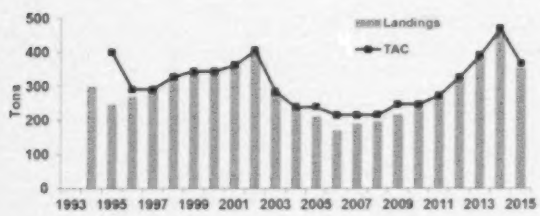

Figure 29. Landings and TAC in Area 12B from 1994 to 2015.

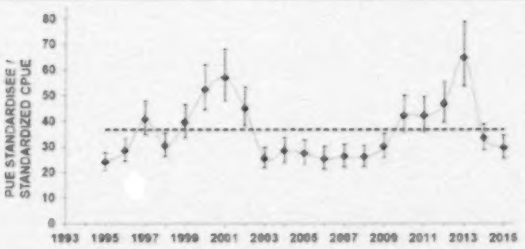

Figure 30. Standardized CPUE ± confidence interval in the commercial fishery from 1995 to 2015 in Area 12B. The dotted line shows the data series average.

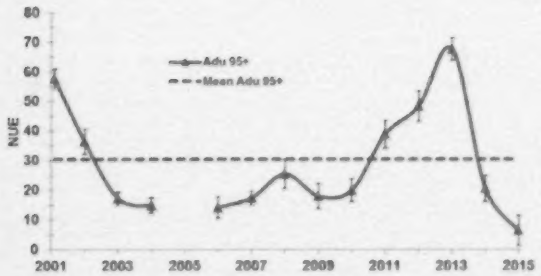

Figure 31. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-season survey in Area 12B from 2001 to 2015 (except for 2005).

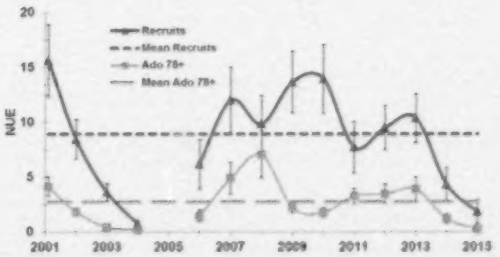

Figure 32. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 12B from 2001 to 2015 (except for 2005).

Perspectives and conclusions

The uncertainty linked to the crab's range during the post-season survey provides a rationale for increasing the weighting of the commercial biomass indicator during the fishery CPUE). However, this indicator suggests that 2016 catches should decrease compared to 2015:

1) A decrease in catches of 10% or less could lead to high harvesting intensity.
2) A decrease of approximately 15% could lead to moderate harvesting intensity.
3) A greater decrease could help stabilize the biomass available to the fishery.

Area 12C

Description of the Fishery

Area 12C includes two banks (north and south sectors) separated by the deep Anticosti Channel. In Area 12C, there are five traditional licences with 68.7% of the TAC and 24 not traditional licences with 31.3% of the TAC. The TAC peaked at 352 t in 2014, then it decreased by 10% in 2015 to 316 t (Figure 33). The fishery opened on April 20 and closed on July 26. The TAC was reached.

Resource status in 2015

Commercial fishery. The standardized CPUE is stable and has been close to the average since 2013 (Figure 34). The fishing effort was concentrated mainly north of the area, near the Area 15 boundary.

Recruits (carapace conditions 1 and 2), whose numbers were increasing in landings from 2011 to 2013, formed a slightly lower proportion in landings than intermediate-shell crabs (carapace condition 3) in 2014 and 2015.

Fishery-independent survey. The trap-based research survey conducted since 2000 shows that the NUE of adults ≥ 95 mm decreased sharply since 2012, to a low value in 2015 (Figure 35). The NUE of recruits decreased compared to 2014 but remains slightly above average, whereas that of adolescents ≥ 78 mm, which decreased from 2010 to 2014, remained stable in 2015 at a value close to the average (Figure 36). These results suggest a decreased biomass available to the fishery in the short and medium term.

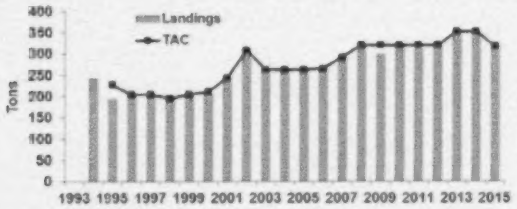

Figure 33. Landings and TAC in Area 12C from 1994 to 2015.

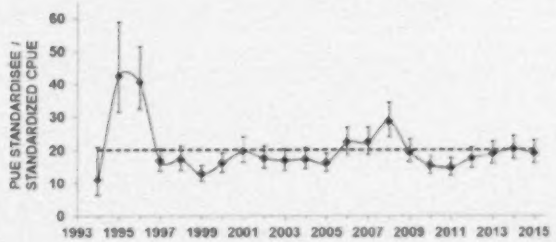

Figure 34. Standardized CPUE ± confidence interval in the commercial fishery from 1994 to 2015 in Area 12C. The dotted line shows the data series average.

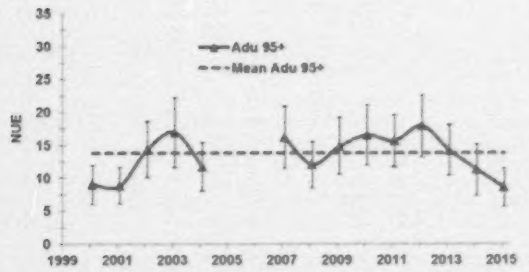

Figure 35. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm and those left by the fishery, from the post-season survey in Area 12C from 2000 to 2015 (except for 2005 and 2006).

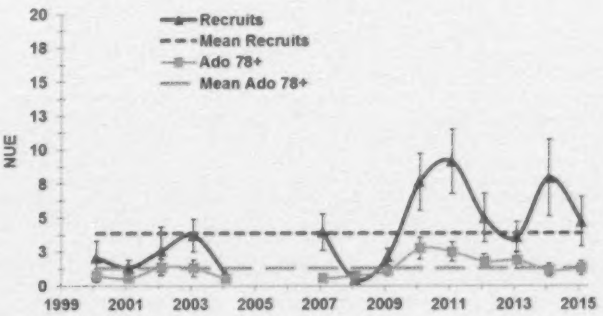

Figure 36. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 12C from 2000 to 2015 (except 2005 and 2006).

The combined index of commercial CPUE and of NUE from the post-season survey decreased and is below average, suggesting a decrease in the biomass available to the fishery in 2016 compared to 2015.

Perspectives and conclusions

The drop in the combined index suggests that 2016 catches should decrease compared to 2015:

1) A status quo in catches could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;

2) It is unlikely that a 10 to 15% decrease would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;

3) Any decrease greater than 15% could lead to the maintenance of a substantial biomass available to the fishery over a longer period of time.

Area 16A

Description of the Fishery

Area 16A includes two banks (north and south parts) separated by the Anticosti Channel. Since 2002, it has been accessible to the 43 Quebec fishers holding a Snow Crab fishing licence in Area 13. The TAC was 515 t in 2014 and increased by 10% in 2015, peaking at 566 t. The TAC was reached (Figure 37). In 2015, the fishery opened on April 19 and closed on July 25.

Resource status in 2015

Commercial fishery. The standardized CPUE increased from 2011 to 2014 and then decreased in 2015 to the historical average (Figure 38). Recruits (carapace conditions 1 and 2), whose numbers were increasing in landings from 2011 to 2013, formed a lower proportion in landings than intermediate-shell crabs (carapace condition 3) in 2014 and 2015.

Fishery-independent survey. The trap-based research survey, conducted since 2002, shows that the NUE of adults ≥ 95 mm decreased in 2015 compared to 2014, to a value below the historical average (Figure 39). The NUE for recruits decreased, but remains high, whereas that of adolescents ≥ 78 mm decreased from 2011 to 2013 and then remained slightly below average until 2015 (Figure 40). These results suggest that recruitment will be lower in the short to medium term. It is important to note that the temperature increase in the deep layer of the Anticosti Channel and the thinning of the cold intermediate water layer could have resulted in a given displacement of crab to shallow waters not sampled by the survey.

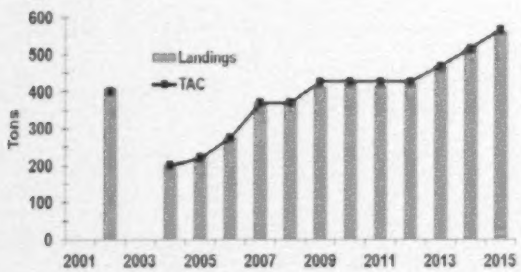

Figure 37. Landings and TAC in Area 16A from 2002 to 2015.

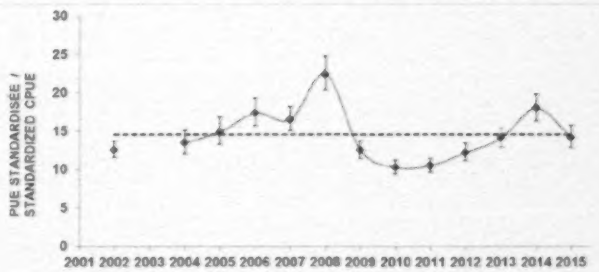

Figure 38. Standardized CPUE ± confidence interval in the commercial fishery from 2002 to 2015 in Area 16A. The dotted line shows the data series average.

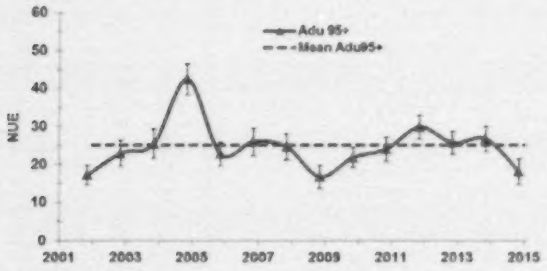

Figure 39. Catch rates (NUE), with confidence interval and average, of adult crabs ≥ 95 mm from the post-season survey in Area 16A from 2002 to 2015.

Figure 40. Catch rates (NUE), with confidence interval and average, of adolescent crabs ≥ 78 mm and recruits from the post-season survey in Area 16A from 2002 to 2015.

The combined index of commercial CPUE and of average NUE from the post-season survey decreased in 2015 compared to 2014 and is below the average. This suggests that the biomass available to the fishery will be lower in 2016 than in 2015.

Perspectives and conclusions

The uncertainty linked to the crab's range during the post-season survey provides a rationale for increasing the weighting of the commercial biomass indicator during the fishery (CPUE). However, this indicator suggests that 2016 catches should decrease compared to 2015:

1) A less than 15% decrease in catches could lead to a high harvesting intensity and would increase the effect of lower expected recruitment;
2) It is unlikely that a 15 to 20% decrease would lead to an excessively high harvesting intensity and would moderate the effect of lower expected recruitment;
3) Any greater decrease could help maintain a substantial biomass available to the fishery over a longer period of time.

Sources of Uncertainty

The quality of scientific advice depends mainly on the accuracy of parameters obtained through sampling and the subsequent analyses. Information obtained from logbooks and purchase slips during the fishing season affects the accuracy of the parameters derived from these documents. For instance, abundance indices and fishing effort calculations obtained from logbooks may include errors that will affect the scientific advice provided. The selectivity and catchability of traps can vary depending on the type of trap used, its volume and the size of the mesh covering the trap, the amount and quality of bait used and soak time, which can vary with the fishing strategies employed and prevailing environmental conditions. The catchability of adolescent crabs and recruits can also be affected by the abundance of intermediate-size crabs (carapace condition 3) on the seafloor. The selective sorting of catches can also affect the quality of the data obtained.

The abundance and condition indices and the estimates of crab size obtained from the trawl and trap surveys depend on the type of gear used and are affected by uncertainties related to catchability variations in the different crab groups targeted. Some types of fishing gear are better suited to given seafloor areas than other types and this factor influences the spatial coverage ultimately sampled. The biological characteristics specific to Snow Crabs can also create sources of uncertainty that impinge on

the scientific advice. For instance, the terminal moulting phase, which occurs at various sizes, will affect crab condition and catchability. Natural mortality can also vary with the life stage and condition of the crabs.

OTHER CONSIDERATIONS

Snow Crab distribution is linked to the thickness (and temperature) of the cold intermediate water layer, which is its benthic phase habitat. However, the temperature increase of the deep layer, observed for several years in the Gulf of St. Lawrence, accompanied by a warming of the surface layer, may reduce crab habitat area and affect its distribution. The length of early pelagic larval development stages and larvae survival are linked with water surface temperatures (mainly in spring and summer) just as egg incubation length and crab growth are linked with the temperature of the bottoms in which they develop. It thus seems that stock distribution and productivity could change according to the temperature in the various water layers.

Warming waters' effect on crab productivity and stock distribution is a real issue. Impacts could vary significantly in different regions or areas.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 16 and 17, 2016 meeting on the Assessment of the Estuary and northern Gulf of St. Lawrence Snow Crab stocks. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

Dufour, R. and J.-P. Dallaire. 2003. Snow Crab of the Estuary and Northern Gulf of St Lawrence: Status of populations from 1999 to 2001. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/048. [In French only]

DFO. 2015. Assessment of the Estuary and Northern Gulf of St. Lawrence (Ares 13 to 17, 12A, 12B, 12C and 16A) Snow Crab Stocks in 2014. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/033.

Sainte-Marie, B., J.-M. Sévigny and M. Carpentier. 2002. Interannual variability of sperm reserves and fecundity of primiparous females of the snow crab (*Chionoecetes opilio*) in relation to sex ratio. Can. J. Fish. Aquat. Sci. 59: 1932-1940.

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